Chapter 5
Sampling Protocols

Sampling protocols for monitoring vital signs are study plans detailing how "data are to be collected, managed, analyzed, and reported, and are a key component of quality assurance for natural resource monitoring programs" (Oakley et al. 2003:1000). Protocols consist of three main sections: 1) narrative; 2) standard operating procedures; and 3) supplementary materials (Oakley et al. 2003). The protocol narrative describes why a particular vital sign and metric(s) were selected; specifies objectives and details of the proposed sampling design to meet those objectives; identifies field methods that will be used to gather data; explains how these data will be managed, analyzed, and reported; discusses personnel requirements and training procedures; and describes operational requirements such as scheduling, equipment, and budget. Standard operating procedures provide detailed instructions on how to accomplish every topic mentioned in the narrative. Supplementary information includes relevant sources of data such as sample databases and digital images (Oakley et al. 2003).

SWAN staff met with cooperators from SWAN parks, NPS Alaska Regional Office (NPS-ARO), and USGS-BRD during January 2005 to discuss an implementation schedule for sampling protocols for the next 5 yr. Three full protocols are scheduled for implementation and testing during the first year (2006): Glacier Extent, Landscape Processes, and Resident Lake Fish. Table 5-1 displays the 5-yr (2006–2010) schedule of development and testing of protocols monitored only by SWAN or monitored in partnership with SWAN parks or other agencies. See Section 8.4 in Chapter 8 of this report for further details on partnerships with other agencies.

A protocol development summary (PDS) briefly describes key elements of sampling protocols that will be implemented within 3–5 yr of initial draft release of the Phase III Report (see http://science.nature.nps.gov/im/monitor/ for the basic guidelines). A summary of the justification and measurable objectives for all PDSs is provided in Table 5-2; the PDSs are in Appendix III.

Table 5-1 *Schedule for developing and testing protocols for vital signs monitored only by SWAN or in partnership with SWAN parks or with other federal and state agencies.* Develop Draft *refers to the period during which input on the proposed protocol is solicited from park staff, agency partners, and other subject area experts,* Implement and Test *is the period when protocols are field tested, and* Peer Review & Finalize *is the time when protocols undergo formal peer review and are modified accordingly as a prelude to final acceptance.*

SWAN Project	Vital Sign and Protocol	Protocol Development Status				
		2006	**2007**	**2008**	**2009**	**2010**
Weather and Climate	Weather and Climate		*Develop Draft*	Implement & Test	**Peer Review & Finalize**	
Landscape Dynamics and Terrestrial Vegetation	Glacier Extent	Implement & Test	**Peer Review & Finalize**			
	Sensitive Vegetation Communities		*Develop Draft*	Implement & Test	**Peer Review & Finalize**	
	Vegetation Composition and Structure	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	Land Cover/Land Use		*Develop Draft*	Implement & Test	**Peer Review & Finalize**	
	Landscape Processes	Implement & Test	**Peer Review & Finalize**			
Marine Nearshore	Geomorphic Coastal Change	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	Marine Water Chemistry	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	Kelp and Eelgrass	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	Marine Intertidal Invertebrates	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	Black Oystercatcher	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	Seabirds	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	River Otter (Coastal)	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
	Sea Otter	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
Lakes, Rivers, and Fish	Surface Hydrology		*Develop Draft*	Implement & Test	**Peer Review & Finalize**	
	Freshwater Chemistry	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		

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Table 5-1 (continued)

SWAN Project	Vital Sign and Protocol	Protocol Development Status				
		2006	2007	2008	2009	2010
Lakes, Rivers, and Fish cont.	Resident Lake Fish	Implement & Test	**Peer Review & Finalize**			
	Salmon	*Develop Draft*	Implement & Test	**Peer Review & Finalize**		
Terrestrial Animals	Bald Eagle			*Develop Draft*	Implement & Test	**Peer Review & Finalize**
	Brown Bear		*Develop Draft*	Implement & Test	**Peer Review & Finalize**	
	Wolf			*Develop Draft*	Implement & Test	**Peer Review & Finalize**
	Wolverine			*Develop Draft*	Implement & Test	**Peer Review & Finalize**
	Moose			*Develop Draft*	Implement & Test	**Peer Review & Finalize**
Human Activities	Visitor Use		*Develop Draft*	Implement & Test	**Peer Review & Finalize**	

Table 5-2 *Justifications and measurable objectives for sampling protocols used to monitor vital signs within SWAN parks.*

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Weather and Climate	Visibility and Particulate Matter	ANIA, LACL	Airborne pollutants and increased particulate loads have potential to affect climatic conditions and ecological processes.	-- Develop a protocol to acquire aerosol data and summary reports from the Interagency Monitoring of Protected Visual Environments (IMPROVE) sites in southwest Alaska.
	Weather and Climate	KATM, KEFJ, LACL	Climate is a basic driver of all ecological systems. Global climate models predict climate change and variability will be most severe at high latitudes, and there are many indications that environmental conditions are already changing in Alaska.	-- Record and archive hourly weather parameters, including temperature, precipitation, wind speed/direction, solar radiation, relative humidity, and snow depth at weather stations located in representative areas within SWAN parks. -- Produce monthly and annual summaries of climatic parameters and identify extremes of climatic conditions for common parameters (precipitation and air temperature), and other parameters for which sufficient data are available (e.g., wind speed and direction, solar radiation).
Landscape Dynamics and Terrestrial Vegetation	Glacier Extent	KATM, KEFJ, LACL	Glaciers are highly sensitive, natural, large-scale, representative indicators of the energy balance of both mountains and lowlands within SWAN, but they have been in widespread retreat and thinning in SWAN parks since the Little Ice Age (1900).	-- Document whether the surface area of glacier ice cover is growing or shrinking, the rate of any change, and where the greatest change is occurring.
	Volcanic and Earthquake Activity	All	Earthquake occurrence is common in the SWAN parks and region. The location and magnitude of seismic events could be significant in terms of human health and safety and landscape change (mass movement).	-- Record the occurrence and magnitude of seismic events (earthquakes) in the SWAN parks and region. -- Record the occurrence and magnitude of volcanic events (eruptions and/or ash deposition events) in the SWAN parks and region.
	Invasive/Exotic Species	All	The level of invasive exotic species infestation is currently very low in SWAN parks, but the combined effects of environmental warming and human activities in previously remote areas will likely increase the rate of exotics introduction and facilitate their establishment in park ecosystems.	-- Monitor number of nonnative, vascular plant species in or near SWAN parks. -- Monitor amount of acreage infested by nonnative vascular plant species in or near SWAN parks. -- Estimate long-term rate of change in acreage infested by nonnative vascular plant species in or near SWAN parks.

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Table 5-2 (continued)

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Landscape Dynamics and Terrestrial Vegetation *(cont'd)*	Insect Outbreaks	All	Disturbance is an important force regulating landscape pattern and process in SWAN parks. High-latitude forests have experienced widespread mortality and/or loss of canopy cover due to insect and disease outbreaks in the past. Resultant changes in stand structure and composition have the potential to substantially affect primary productivity, fuel loads and fire regimes, wildlife habitat and foraging patterns, biogeochemical cycling, and water quality.	-- Detect the establishment of new native and nonnative insects and pathogens in SWAN parks, as identified by ADNR/USFS inventories. -- Use ADNR/USFS inventory data to monitor extent and rate of expansion of insect and disease outbreaks in SWAN parks over 1-, 5-, and 10-year intervals. -- Identify areas in SWAN that have experienced the greatest insect-related mortality (e.g., post-stratify by elevation class and/or landform).
	Sensitive Vegetation Communities	All	High-latitude plant communities are expected to be sensitive to increased climatic variation and physical disturbance, and hence they may serve as early indicators of environmental change on the landscape.	--Estimate long-term changes in species richness, cover and diversity in focal ecosystems in KATM, KEFJ, and LACL. --Where applicable, estimate long-term changes in the density of seedlings, saplings, and mature trees and/or shrubs at these sites.
	Vegetation Composition and Structure	All	Vegetation is integral to ecosystem function, energy transfer, and element cycling, and has the potential to both affect and respond to environmental drivers. Vegetation composition and structure are shaped by many factors, including climate, disturbance, and biotic interactions, and thus are excellent integrators of these forces on the landscape.	-- Map long-term, landscape-scale changes in the distribution and extent of major land cover classes in SWAN using satellite imagery and/or aerial photographs. -- Quantify long-term changes in the extent of land cover classes in SWAN. -- Quantify long-term changes in the distribution of land cover classes in SWAN. -- Estimate long-term changes in species richness, cover and diversity in focal ecosystems in KATM, KEFJ, and LACL. -- Where applicable, estimate long-term changes in the density of seedlings, saplings, and mature trees and/or shrubs at these sites.

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Table 5-2 (continued)

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Landscape Dynamics and Terrestrial Vegetation *(cont'd)*	Land Cover/Land Use	All	Human-induced changes in biological diversity and modification of ecosystem processes are two of the more pronounced ecological trends of the last century. Model simulations and empirical data indicate that a combination of land use change and climatic variation could have profound impacts on subarctic vegetation, both through vegetation loss and changes in species composition.	-- Map long-term, landscape-scale changes in vegetation to identify areas where vegetation loss is occurring due to human activities in and adjacent to SWAN. -- Document changes in land-use patterns in and adjacent to SWAN parks.
	Landscape Processes	All	Climate and terrain, and the interactions between them, are the major landscape drivers in SWAN parks. Important landscape processes include freeze-up and break-up of large freshwater and marine water bodies, pattern and timing of snow cover, pattern and timing of surface sediment in large lakes, timing of vegetation green up and senescence, and relative biomass.	-- Track long-term trends in lake freeze-up and ice break-up dates in large lakes in SWAN parks. -- Estimate long-term trends in duration of snow cover in SWAN parks. -- Estimate long-term trends in spatial extent of August sediment plumes for Lake Clark, Naknek Lake, and Resurrection Bay offshore of Bear Glacier. -- Estimate long-term trends in the normalized difference vegetation index (NDVI) during growing seasons in SWAN parks.
Marine Nearshore	Geomorphic Coastal Change	KATM, KEFJ, LACL	Shoreline change is a prime geo-indicator of coastal environmental resource threats within parks. The physical configuration of the SWAN coastal shoreline is dynamic and constantly changing due to coastal erosion and accretion from natural events. Changes in the position of the shoreline affect the composition, relative abundance, and distribution of coastal habitats.	-- Document changes in the width of the dry beach, position of the mean water line, the high water line, and the base of the beach. -- Document how the position of top and toe of the bluffs is changing. -- Document how the position of foreshore and backshore vegetation is changing. -- Document how the sediment type and grain size is changing between the high water line and the base of the beach.

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Table 5-2 (continued)

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Marine Nearshore *(cont'd)*	Marine Water Chemistry	KATM, KEFJ, LACL	Water chemistry is critical to intertidal fauna and flora and is likely to be an important determinant of both short- and long-term fluctuations in the intertidal biotic community.	-- Acquire regional synoptic nearshore oceanographic data collected by the Alaska Ocean Observing System and incorporate into regional (SWAN) data sets. -- Document daily, seasonal, and annual variability and gradients in temperature and salinity at randomly selected shallow water (< 20 m) nearshore sampling sites.
	Kelp and Eelgrass	KATM, KEFJ, LACL	Kelp and eelgrass are "living habitats" that serve as a nutrient filter and provide understory and ground cover for planktivorous fish, clams, and urchins, and a physical substrate for invertebrates, crustose corals, and algae. Kelp plants are the major primary producers in the marine nearshore.	-- Estimate long-term trends in abundance and distribution of kelp and seagrass along marine coastlines of KATM, KEFJ, and LACL.
	Marine Intertidal Invertebrates	KATM, KEFJ, LACL	Marine intertidal invertebrates provide a critical prey resource for shorebirds, ducks, fish, bears, sea otters, and other marine invertebrate predators, as well as spawning and nursery habitats for forage fish and juvenile crustaceans.	-- Monitor long-term trends in invertebrate species richness in randomly sampled sites along marine coastlines. -- Document how the size distribution of limpets and mussels is changing annually in randomly sampled sites along marine coastlines of KATM, KEFJ, and LACL. -- Estimate long-term trends in abundance of littleneck clams in randomly sampled sites along marine coastlines of KATM, KEFJ, and LACL. -- Document how the size distributions and growth rates of littleneck clams are changing annually in randomly sampled sites along marine coastlines of KATM, KEFJ, and LACL. -- Monitor status and trends in the concentration of metals, organochlorides, PCBs, and mercury in mussel tissues in randomly sampled sites along marine coastlines of KATM, KEFJ, and LACL.

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Table 5-2 (continued)

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Marine Nearshore *(cont'd)*	Black Oystercatcher	KATM, KEFJ	Black oystercatchers are well suited for inclusion into a long-term monitoring program of nearshore habitats because they are long-lived; reside and rely on intertidal habitats; consume a diet dominated by mussels, limpets, and chitons; and provision chicks near nest sites for extended periods.	-- Estimate long-term trends in relative density of black oystercatchers along marine coastlines of KATM and KEFJ.
	Seabirds	KATM, KEFJ, LACL	Seabirds are predators near the top of marine nearshore food webs. Their abundance and population trends reflect the dynamics of the processes that maintain the integrity of the marine nearshore environment.	-- Estimate long-term trends in the seasonal abundance of seabirds along marine coastlines of KATM, KEFJ, and LACL.
	River Otter (Coastal)	KATM, KEFJ, LACL	Where river otter occur in coastal environments they are a keystone species for the land-margin ecosystem and a "sentinel species" for monitoring levels of environmental contamination.	-- Estimate long-term trends in river otter abundance along marine coastlines of KATM, KEFJ, and LACL.
	Sea Otter	KATM, KEFJ, LACL	Sea otters dramatically change the structure and complexity of their nearshore ecological community. The relationship between sea otters and kelp is a prime example of the top-down cascade type of food chain in which the highest trophic level can determine the populations of the lower trophic levels.	-- Estimate long-term trends in sea otter abundance in randomly sampled areas along marine coastlines of KATM, KEFJ, and LACL. -- Estimate and compare age-specific survival rates of sea otters among regions within the Gulf of Alaska.
	Harbor Seal	ANIA, KATM, KEFJ, LACL	Harbor seals perform a dynamic role in the marine nearshore environment by transferring nutrients and energy though their predatory activities and by influencing the physical complexity of their environment. Thus, they may serve as indicators of status and change of the marine nearshore environment.	-- Devise and implement a protocol for obtaining past, present, and future survey data of harbor seals for marine coastlines of ANIA, KATM, KEFJ, and LACL from the Polar Ecosystems Program at NMFS-NMML. -- Estimate long-term trends in abundance and occupancy of harbor seals at haul-outs sampled via aerial photosurvey along marine coastlines of ANIA, KATM, KEFJ, and LACL.

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Table 5-2 (continued)

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Lakes, Rivers, and Fish	Surface Hydrology	All	Climate warming is decreasing glacial coverage in SWAN and increasing evaporation from water and land surfaces. These changes in surface hydrology also influence water chemistry and availability of aquatic habitats to fish and wildlife populations, affect the timing and amount of stream flows, and alter the areas in which boats and floatplanes can be used by park managers and visitors.	-- Monitor maximum and minimum annual daily flow, maximum and minimum annual 3-day or 7-day duration flow, and total annual water yield in selected SWAN river systems. -- Monitor annual trends in the timing and magnitude (average, maximum, minimum) of lake levels in selected SWAN flow systems.
	Freshwater Chemistry	All	Water quality, especially dissolved oxygen, pH, and temperature, is not only important for maintenance of biological life, but can control or alter biogeochemical cycling as well as the toxicity of some elements. Because water quality in SWAN parks is relatively pristine, focus will be on documenting natural variability within park systems, future changes from existing conditions, and changes due to far-field effects such as climate change.	-- Document annual and inter-annual variability in maximum, minimum, and average temperature, pH, dissolved oxygen, specific conductance, and turbidity in selected SWAN flow systems. -- Quantify midsummer lake profiles of temperature, specific conductance, pH, dissolved oxygen, and turbidity on an annual basis for high-priority lake systems, and less frequently for other SWAN lakes. -- Estimate nutrient and chlorophyll concentrations on an annual basis in high-priority lake systems, and less frequently for other SWAN lakes. -- Monitor dissolved major ion, trace elements and alkalinity on an annual basis for high-priority lake systems, and less frequently for other SWAN lakes.

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Table 5-2 (continued)

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Lakes, Rivers, and Fish *(cont'd)*	Resident Lake Fish	All	Resident lake fishes occupy a variety of trophic levels and hence reflect changes that occur in the food chain. They also provide an indicator of environmental contaminants in aquatic systems.	-- Estimate occupancy of important recreational, subsistence, and other endemic species of resident fish every 3–5 years within high priority lakes and every 5–10 years within lower priority lakes in KATM and LACL. -- Estimate long-term trends in relative species richness of resident fish communities in high-priority lake systems within SWAN parks. -- Annually monitor influx of nonendemic fish species every 3–5 years within high priority lakes and every 5–10 years within lower priority lakes in KATM and LACL. -- Collect and archive tissue samples of resident fish for later biocontaminant analysis every 5 years from within high priority lakes and every 10–15 years within lower priority lakes in KATM and LACL.
	Salmon	All	Pacific salmon play a critical role in maintaining productivity of many freshwater and adjacent terrestrial systems, and provide a crucial food resource to brown bears, an excellent recreational opportunity to anglers, and an important subsistence and cultural resource to native Alaskans.	-- Devise and implement a protocol for obtaining past, present, and future data from ADF&G on spawner abundance and distribution, timing of spawning runs, and freshwater residence time of sockeye salmon from sampled systems in SWAN parks. -- Estimate long-term trends in spawner abundance, growth rates and distribution, timing of spawning runs, and freshwater residence time and body condition of sockeye salmon in SWAN parks.
Terrestrial Animals	Bald Eagle	All	Bald eagles are keystone predators on avian (e.g., seabirds) and fish (e.g., salmon) populations and hence serve an important ecological role in freshwater and marine coastal systems.	-- Estimate long-term trends in nest occupancy and productivity from a random sample of bald eagles nesting along interior rivers/lakes and marine coastlines of SWAN parks.

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Table 5-2 *(continued)*

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Terrestrial Animals *(cont'd)*	Brown Bear	ALAG, ANIA, KATM, LACL	Brown bears are an integral part of SWAN parks and are specifically mentioned in the enabling legislation of ANIA, KATM, and LACL. They serve important ecological roles as top predators influencing population dynamics of other species and as means of nutrient transfer from spawning salmon to the terrestrial system.	-- Estimate long-term trends in abundance and area of occupancy of brown bears from a random sample of relevant elevations and terrains in ALAG, ANIA, KATM and LACL.
	Wolf	All	Wolves significantly influence population dynamics of their ungulate prey species and indirectly affect structure, composition, and parkwide patterns of vegetation communities through their influence on ungulate abundance and distribution.	-- Estimate long-term trends in abundance and distribution of wolves from randomly sampled areas in SWAN parks.
	Wolverine	All	Wolverines serve an important ecological role as scavengers and predators, are a significant economic resource to fur trappers, and are effective indicators of the cumulative effects of changes in human harvest and other activities, habitat, and prey populations.	-- Estimate long-term trends in abundance and distribution of wolverines from randomly sampled areas in SWAN parks.
	Moose	ALAG, ANIA, KATM, LACL	Moose have the potential to influence structure and function of terrestrial systems both through browsing effects on vegetational communities and their role as a prey species. They are an important subsistence and cultural resource to local native Alaskans and provide significant recreational opportunities for resident hunters.	-- Estimate long-term trends in abundance, sex composition (bulls:100 cows), age composition (calves:100 cows), and distribution of moose from a random sample of areas in ALAG, ANIA, KATM, and LACL.

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Table 5-2 (continued)

SWAN Project	Vital Sign and Protocol	SWAN Park	Justification	Measurable Objective
Terrestrial Animals *(cont'd)*	Caribou	ALAG, ANIA, KATM, LACL	Caribou have the potential to influence structure and function of terrestrial systems both through grazing effects on vegetational communities and their role as a prey species. Caribou also are an important subsistence and cultural resource to local native Alaskans and provide significant recreational opportunities for resident hunters.	-- Devise and implement a protocol for obtaining past, present, and future survey data of Northern Alaska Peninsula and/or Mulchatna caribou herds in ALAG, ANIA, KATM, and LACL from the multiagency team performing aerial photosurveys and radiotelemetry flights. -- Estimate long-term trends in abundance, calf:cow ratios, extent of occurrence, and area of occupancy of Northern Alaska Peninsula and/or Mulchatna caribou herds in ALAG, ANIA, KATM, and LACL.
Human Activities	Resource Harvest for Subsistence and Sport	ALAG, ANIA, KATM, LACL	The Alaska National Interest Lands Claim Settlement Act of 1980 established the legality of subsistence hunting, fishing, and gathering on 41,458,000 acres of new parklands, including lands within ALAG, ANIA, KATM, and LACL. Subsistence harvest regulations and bag limits are often more liberal than sport harvest and have the potential for depressing wildlife populations in local areas, such as around human population centers or access routes.	-- Track annual harvest of resident and anadromous fish species within ALAG, KATM and LACL. -- Track number and locations of brown bear, black bear, caribou, Dall sheep, and moose harvested annually within Game Management Units and Uniform Coding Units that include portions of ALAG, ANIA, KATM (Preserve), and LACL. -- Track annual harvest levels within and adjacent to ALAG, ANIA, KATM, and LACL for beaver, lynx, river otter, wolf, and wolverine.
	Visitor Use	All	Human presence can have unexpected and significant effects on ecosystems and ecosystem processes. Humans can serve as a vector for exotic species and, through habitat change, decreased competitive ability of resident species. Heavy use can fragment the landscape for sensitive wildlife, modify wildlife behavior through conditioning, and lead to overfishing or overharvest in focal areas.	-- Track annual numbers of recreational visitors in SWAN parks. -- Document timing of visits, activities, and destinations of visitors in SWAN parks. -- Monitor long-term trends in points of visitor origin and entry into SWAN parks.